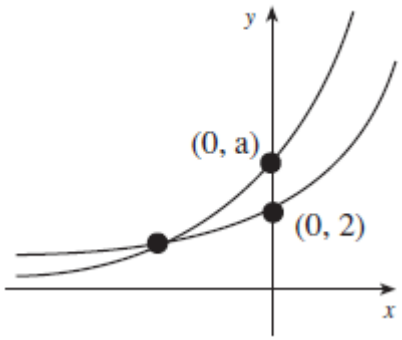
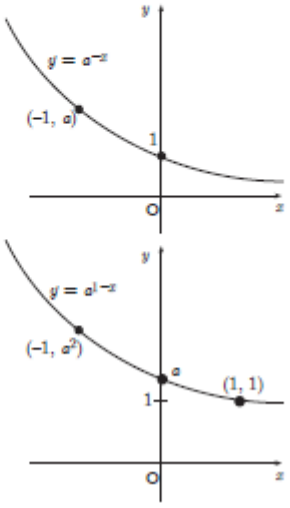
00 P1 B9	**3B** •1 $\log_5 100 - \log_5 4$ •2 $\log_5 25$ •3 2
00 P2 B11	**2A, 4A** •1 $m = \frac{1.8}{3} = 0.6$ •2 $P = 0.6Q + 1.8$ •3 $\ln p = 0 \cdot 6 \ln q + 1 \cdot 8$ •4 $\ln q^{0.6}$ •5 $\ln 6 \cdot 05$ •6 $p = 6 \cdot 05 q^{0.6}$ **OR** •3 $\ln p = \ln a + b \ln q$ •4 $\ln p = 0 \cdot 6 \ln q + 1 \cdot 8$ •5 $\ln a = 1 \cdot 8$ •6 $a = 6 \cdot 05,\ b = 0 \cdot 6$
01 P1 Q8	**3C** •1 $\log_x 6^4 - \log_x 4^2$ •2 $\log_x \frac{6^4}{4^2}$ •3 all processing leading to $x = 81$
01 P1 Q10	**1B, 3A** •1 $a = 1$ *and* $b = 3$ •2 a "log – shaped" graph of the same orientation •3 sketch passes through $(0, -3)$ (labelled) •4 sketch passes through $(7, 0)$ (labelled)
01 P2 Q9	**3C** •1 $2A_0 = A_0 e^{k \times 1.5}$ •2 *e.g.* $1.5k = \ln 2$ •3 $k = 0.46$
02 P1 Q11	**4A** •1 $\log_5 y = -2(\log_5 x) + 1$ •2 $\log_5 y = \log_5 x^{-2} + \ldots$ •3 $\ldots + \log_5 5$ •4 $y = 5x^{-2}$
02 P2 Q7	**3B** •1 $\log_3 (x - 2) = -1$ •2 $x - 2 = 3^{-1}$ •3 $x = 2\frac{1}{3}$
2.(JAN) 02 P1	**2B, 2A** •1 sketch with y – axis reflection •2 sketch with translation $\|l\|$ to y – axis

	•3 $(0,-7)$ •4 $(-3,0)$
5.(JAN) 02 P1	**3A** •1 $\log_a p+\log_a r=\cos^2 x+\sin^2 x$ •1 $p=a^{\cos^2 x}\quad r=a^{\sin^2 x}$ •2 $\log_a p+\log_a r=\log_a pr$ •2 $pr=a^{\cos^2 x+\sin^2 x}$ •3 $\log_a pr=1$ and so $pr=a$ •3 $pr=a^1=a$ **OR**
6.(JAN) 02 P2	**1C, 4B** •1 950 •2 $9500=950\times 2.6^{0.2t}$ OR $10=2.6^{0.2t}$ •3 $\log_{10}10=\log_{10}2.6^{0.2t}$ •4 $0.2t=\dfrac{\log_{10}10}{\log_{10}2.6}$ •5 $t\approx 12$ hours
03 P1 Q12	**4A** •1 $\ln(2e)^3-\ln(3e)^2$ •2 $\ln\left(\dfrac{(2e)^3}{(3e)^2}\right)$ •3 $\ln\left(\frac{8e}{9}\right)$ •4 $1+\ln(8)-\ln(9)$
03 P2 Q11	 •1 expo sketch thr (0,2) •2 expo sketch thr $(0,a)$ •3 $a^{x+1}=a^x+1$ •4 $a\times a^x-a^x=1$ •5 $(a-1)\times a^x=1$ …& complete

	Alternative 1 Let $x = \log_a\left(\frac{1}{a-1}\right)$ Then $\frac{1}{a-1} = a^x$ $y = a^x + 1$ $\quad$ $y = a^{x+1}$ $= \frac{1}{a-1} + 1$ $\quad$ $= a^x \times a$ $= \frac{a}{a-1}$ $\quad$ $= \frac{1}{a-1} \times a$ $= \frac{a}{a-1}$ $\therefore$ curves intersect at $\left(\log_a\left(\frac{1}{a-1}\right), \frac{a}{a-1}\right)$ **Alternative 2** Let $x = \log_a\left(\frac{1}{a-1}\right)$ Then $\frac{1}{a-1} = a^x$ $1 = a^x(a-1)$ $1 = a^{x+1} - a^x$ $a^x + 1 = a^{x+1}$ Hence the graphs intersect
04 P1 Q9	**4A/B** •1 $-\log_2 3^2$ •2 $\log_2\left(\frac{x+1}{3^2}\right) = 3$ •3 $\frac{x+1}{3^2} = 2^3$ •4 $x = 71$ **OR** •1 $\log_2(x+1) - 2\log_2 3 = 3\log_2 2$ •2 $\log_2(x+1) = \log_2 2^3 + \log_2 3^2$ •3 $\log_2(x+1) = \log_2(2^3 \times 3^2)$ •4 $x = 71$
04 P2 Q10	**3C, 4A/B** •1 $600 = A_0 e^{-0.002\times1000}$ •2 $A_0 = \frac{600}{e^{-0.002\times1000}}$ •3 4433 •4 $\frac{1}{2}A_0 = A_0 e^{-0.002t}$ •5 $0.5 = e^{-0.002t}$ •6 $-0.002t = \ln 0.5$ •7 $t = 347$ years **OR** •1 $600 = A_0 e^{-0.002\times1000}$ •2 $\ln A_0 = \ln 600 - \ln e^{-0.002\times1000}$ •3 $A_0 = 4433$
05 P1 Q7	**2C, 1C**

	•1 $a = 4$ •2 $b = 5$ •3 domain is $x > a$
05 P2 Q7	**4A** •1 $\log_4\left(\frac{5-x}{3-x}\right)$ •2 *use* $\log_a(b) = c \Leftrightarrow b = a^c$ •3 $\frac{5-x}{3-x} = 4^2$ •4 $x = \frac{43}{15}$ **OR** •1 $\log_4\left(\frac{5-x}{3-x}\right)$ •2 $2\log_4 4$ •3 $\left(\frac{5-x}{3-x}\right) = 4^2$ •4 $x = \frac{43}{15}$
05 P2 Q9	**1B, 4A** •1 $V_{t=0} = 252\,(£m)$ •2 $252e^{-0.06335t} = 20$ •3 $e^{-0.06335t} = \frac{20}{252}$ •4 $-0.06335t = \ln\left(\frac{20}{252}\right)$ •5 $t = 40$
06 P1 Q10	**4A** •1 $\log_4(y) = \log_4(a^x)$ •2 $3 = \log_4(a^6)$ •3 $a^6 = 4^3$ •4 $a = 2$ **OR** •3 $\log_4(a) = \frac{1}{2}$ •4 $a = 2$ **OR** •1 $\log_4(y) = mx + c$ •2 $m = \frac{1}{2},\ c = 0$ •3 $y = 4^{\frac{1}{2}x}$ •4 $y = \left(4^{\frac{1}{2}}\right)^x = 2^x \Rightarrow a = 2$ **OR** •1 At A $\log_4(y) = 3$ •2 $y = 4^3$ •3 $a^6 = 4^3$ •4 $a = 2$ **OR** •1 $\log_4(y) = \log_4(a^x)$ •2 $\log_4(y) = x\log_4(a)$ •3 $\log_4(a) = \frac{1}{2}$ •4 $a = 4^{\frac{1}{2}} = 2$
06 P2 Q11	**5A/B** •1 $A(t) = 0.88A_0$ stated or implied •2 $e^{-0.000124t} = 0.88$ •3 $\ln\left(e^{-0.000124t}\right) = \ln(0.88)$ stated or implied •4 $-0.000124t = \ln(0.88)$ •5 $t = 1031$ years so claim valid **OR**

	•1 $A(1000) = A_0 e^{-0.000124\times1000}$ •2 $0.883A_0$ *and* 1000 year old piece of wood contains 88.3% carbon. •3 try a point where t > 1030 *e.g.* $A(1050)$ getting $0.878A_0$ •4 sketch of $y=A_0e^{-0.000124t}$ showing 1. a monotonic decreasing function 2. points representing eg (1000, 88.3%) etc •5 observation that the point lies between the two plotted values for t and so claim valid.
07 P2 Q8	**4B** •1 $\log_3(a-1)-2.2=0$ s/i by •2 •2 $\log_3(a-1)=2.2$ •3 $a-1=3^{2.2}$ •4 $a=12.2$ *Alt.method 1* •1 $\log_3(a-1)-2.2=0$ s/i by •2 •2 $\log_3(a-1)=2.2$ •3 $\log_3(a-1)=\log_3(11.21)$ •4 $a=12.2$ *Alt.method 2* •1 $\log_3(a-1)-2.2=0$ s/i by •2 $\log_3(a-1)-2.2\log_3 3=0$ •2 $\log_3(a-1)-\log_3(11.21)=0$ •3 $\log_3\frac{(a-1)}{11.21}=0$ •4 $a=12.2$
07 P2 Q9	**2B, 2A**

	$\bullet^1$ reflecting in y-*axis* and passing thr' e.g. $(0,1)$ $\bullet^2$ passing thr' 1 more point e.g. $(-1,a)$ *or* $\left(1,\frac{1}{a}\right)$ $\bullet^3$ vertical scaling of "a" and passing thr' e.g. $(0,a)$ $\bullet^4$ passing thr' 1 more point e.g. $(-1,a^2)$ *or* $(1,1)$ 
07 P2 Q11	**1B, 1C, 4A** $\bullet^1$ $a = \frac{1}{2}$ $\bullet^2$ $b = \frac{3}{2}$ $\bullet^3$ $\log_{10}(y) = \log_{10}\left(3 \times 4^x\right)$ $\bullet^4$ $\log_{10}(y) = \log_{10}(3) + \log_{10}\left(4^x\right)$ $\bullet^5$ $\log_{10}(y) = x\log_{10}(4) + \log_{10}(3)$ $\bullet^6$ *gradient* $= \log_{10}(4)$ or equivalent *Alternative Method* $\bullet^1$ $y = 10^{Px+Q}$ $\bullet^2$ $y = 10^Q \times (10^P)^x$ $\bullet^3$ $10^Q = 3$ *and* $10^P = 4$ $\bullet^4$ $P = \log_{10} 4$
08 P1 Q23	**3C, 5A/B** $\bullet^1$ $h\left(f(x)\right) = h\left(x^2 - x + 10\right)$ *s / i by* $\bullet^2$ $\bullet^2$ $\log_2\left(x^2 - x + 10\right)$ $\bullet^3$ $\log_2(5 - x)$ $\bullet^4$ $\log_2\left(\frac{x^2 - x + 10}{5 - x}\right)$ $\bullet^5$ $\frac{x^2 - x + 10}{5 - x} = 2^3$ $\bullet^6$ $x^2 - x + 10 = 8(5 - x)$ $\bullet^7$ $x^2 + 7x - 30 = 0$ $\bullet^8$ $x = 3,\ -10$
09 P2 Q3	**4C, 5B**

	•1 $\begin{array}{c\|cccc} & 1 & 8 & 11 & -20 \\ 1 & & 1 & & \\ \hline & 1 & 9 & & \end{array}$ $\begin{array}{c\|cccc} & 1 & 8 & 11 & -20 \\ 1 & & 1 & 9 & 20 \\ \hline & 1 & 9 & 20 & 0 \end{array}$ •2 $rem. = 0$ so $x = 1$ *is root* OR •1 $f(1) = 1+8+11-20 = 0$ *so* $x = 1$ *is a root* •2 $(x-1)(x^2 \ldots\ldots)$ •3 $(x^2+9x+20)$ •4 $(x-1)(x+4)(x+5)$ **Stated explicitly** •5 $\log_2\left((x+3)(x^2+5x-4)\right)$ **s / I by •6** •6 $(x+3)(x^2+5x-4) = 2^3$ •7 $x^3+8x^2+11x-20 = 0$ •8 $x = 1$ *or* $x = -4$ *or* $x = -5$ **Stated explicitly here** •9 $x = 1$ *only*
09 P2 Q6	**2B, 3A** •1 $61e^{0.016\times14}$ •2 76 million *or equiv.* •3 $10.2 = 5.1e^{0.0043t}$ •4 $0.0043t = \ln 2$ •5 $t = 161.2$ years **Options** **1** •1 $61000000e^{0.016\times14}$ •2 76000000
10 P2 Q7	convert from log to exponential form know to and convert back to log form process and complete •1 $x = 4^P$ •2 $\log_{16} x = \log_{16} 4^P$ •3 $\log_{16} x = P\times\log_{16} 4$ and complete •4 $\log_3 x + \frac{1}{2}\log_3 x = 12$ •5 $\log_3 x = 8$ •6 $x = 3^8$ $(= 6561)$ **or** •4 $Q + \frac{1}{2}Q = 12$ $Q = 8$ •5 $\log_3 x = 8$ •6 $x = 3^8$ $(= 6561)$ •4 $2\log_9 x + \log_9 x = 12$ •5 $\log_9 x = 4$ •6 $x = 9^4$ $(= 6561)$ **or** •4 $2Q + Q = 12$ $Q = 4$ •5 $\log_9 x = 4$ •6 $x = 9^4$ $(= 6561)$

11 P2 Q5

Method 1

introduce logarithms to $y =$	$\bullet^1$	$\log_2 y = \log_2 kx^n$	**stated explicitly**
use laws of logarithms	$\bullet^2$	$\log_2 y = n\log_2 x + \log_2 k$	**stated explicitly**
interpret intercept	$\bullet^3$	$\log_2 k = 5$ **or** $\log_2 y = 5$	Accept without working
solve for k	$\bullet^4$	$k = 32$ or 2^5	
interpret gradient	$\bullet^5$	$n = \frac{1}{2}$	Accept without working

Method 2

state linear equation	$\bullet^1$	$\log_2 y = \frac{1}{2}\log_2 x + 5$	$\bullet^1$	$\log_2 y = \frac{1}{2}\log_2 x + 5$
introduce logarithms	$\bullet^2$	$\ldots + 5\log_2 2$ or $\ldots + \log_2 2^5$	$\bullet^2$	$\log_2 y = \log_2 x^{\frac{1}{2}} + 5$
use laws of logarithms	$\bullet^3$	$\log_2 y = \log_2 x^{\frac{1}{2}} + \ldots$	$\bullet^3$	$\log_2 \left(\frac{y}{x^{\frac{1}{2}}} \right) = 5$
use laws of logarithms	$\bullet^4$	$\log_2 y = \log_2 2^5 x^{\frac{1}{2}}$	$\bullet^4$	$\frac{y}{x^{\frac{1}{2}}} = 2^5$
interpret result	$\bullet^5$	$y = 2^5 x^{\frac{1}{2}}$	$\bullet^5$	$y = 2^5 x^{\frac{1}{2}}$

12 P2 Q7

equate expressions for y	$\bullet^1$	$4^x = 3^{2-x}$	
take logarithms of both sides	$\bullet^2$	$\log_a (4^x) = \log_a (3^{2-x})$	**stated, or implied**
use law of logs : $\log_a x^n = n\log_a x$	$\bullet^3$	$x\log_a 4 = (2-x)\log_a 3$	
gather like terms	$\bullet^4$	$x(\log_a 4 + \log_a 3) = 2\log_a 3$	
use law of logs : $\log_a p + \log_a q = \log_a pq$	$\bullet^5$	$x\log_a 12 = \log_a 9$	
complete to required form	$\bullet^6$	$\frac{\log_a 9}{\log_a 12}$	**stated explicitly**
substitute in for x	$\bullet^7$	e.g. $y = 4^{\frac{\log_a 9}{\log_a 12}}$	
process y	$\bullet^8$	e.g. $y \approx 4^{0\cdot8842} \approx 3\cdot4$	

Method 2

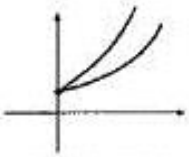
- $\bullet^1$ $4^x = 3^{2-x}$
- $\bullet^2$ $\log_3 (4^x) = 2 - x$
- $\bullet^3$ $x\log_3 4 = 2 - x$
- $\bullet^4$ $x = \frac{2}{1 + \log_3 4}$
- $\bullet^5$ $\frac{2\log_3 3}{\log_3 12}$

Method 3

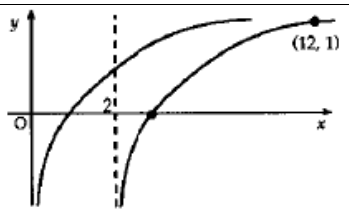
- $\bullet^1$ $4^x = 3^{2-x}$
- $\bullet^2$ $4^x = \frac{3^2}{3^x}$
- $\bullet^3$ $12^x = 9$
- $\bullet^4$ $\log_a 12^x = \log_a 9$
- $\bullet^5$ $x\log_a 12 = \log_a 9$

13 P2 Q5	use correct law of logs	$\bullet^1$	$\log_5[(3-2x)(2+x)]=1$ stated or implied by $\bullet^2$
	know to and convert to exponential form	$\bullet^2$	$(3-2x)(2+x)=5^1$
	express as an equation in standard quadratic form	$\bullet^3$	$2x^2+x-1=0$
	solve quadratic	$\bullet^4$	$x=\frac{1}{2}$, $x=-1$
13 P2 Q9	interpret half-life	$\bullet^1$	$\frac{1}{2}P_0=P_0e^{-25k}$ **stated or implied by $\bullet^2$**
	process equation	$\bullet^2$	$e^{-25k}=\frac{1}{2}$
	write in logarithmic form	$\bullet^3$	$\log_e\frac{1}{2}=-25k$
	process for k	$\bullet^4$	$k\approx 0{\cdot}028$
	interpret equation	$\bullet^5$	$P_t=P_0e^{-80\times 0{\cdot}028}$
	process	$\bullet^6$	$P_t\approx 0{\cdot}1065P_0$
	state percentage decrease	$\bullet^7$	89%
14 P1 Q24			**Method 1**
	take $\log_9$ of both sides of the equation	$\bullet^1$	$\log_9 y=\log_9 ka^x$
	apply laws of logarithms	$\bullet^2$	$\log_9 y=\log_9 k+\log_9 a^x$
	apply laws of logarithms	$\bullet^3$	$\log_9 y=\log_9 k+x\log_9 a$
	find k	$\bullet^4$	$\log_9 k=2, k=81$ or $k=9^2=81$
	find a	$\bullet^5$	$\log_9 a=\frac{1}{2}, a=3$ or $a=9^{1/2}=3$
			Method 2
	know to use equation of the line	$\bullet^1$	$\log_9 y=\frac{1}{2}x+2$
	write in exponential form	$\bullet^2$	$y=9^{\frac{1}{2}x+2}$
	apply laws of indices	$\bullet^3$	$y=9^{\frac{1}{2}x}9^2$
	find k	$\bullet^4$	$k=81$
	find a	$\bullet^5$	$a=3$

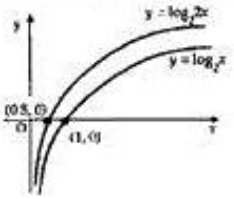
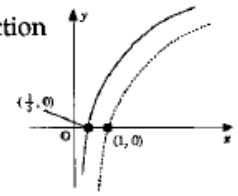
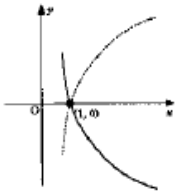
ANSWERS - **Pre 2000 - Exponential Graphs**

1	•1 $t = a$ •2 $a = 0$ •3 both passing thr' same point on $y-$axis •4 $y = a^{2x}$ starting below $y = a^x$ and finishing above •5 $(1, a^2)$  For mark 3  For mark 4
2	•1 $3 = ke^0 \Rightarrow k = 3$ •2 $y = 3e^{0.5}$ or equivalent •3 $(1, 4\cdot9)$

ANSWERS - **Pre 2000 - Log Graphs**

1	•1 *know* $x = 2$ is assymptote •2 graph passes thr' $(3,0)$ •3 graph passes thr' another marked point *e.g.* $(12,1)$ 
2	•1 $\log_{10}(-2+a) = 0$ •2 3
3	•1 $a = -2$ OR •1 $1 = \log_b(7+a)$ **and** $0 = \log_b(a+3)$ •2 $1 = \log_b(7-2)$ •2 $7 + a = b$ **and** $a + 3 = b^0$ •3 $b = 5$ •3 $a = -2,\ b = 5$

ANSWERS - **Pre 2000 - Log Graphs using Laws of Logs**

1	•1 *strat:* $\log_2 2x = \log_2 2 + \log_2 x$ •2 translating graph upwards 1 unit •3 $\left(\frac{1}{2}, 0\right)$ clearly marked 
2	•1 sketch of new function •2 $\log_5 x + 1 = 0$ •3 $\left(\frac{1}{5}, 0\right)$  •4 $\log_5 \frac{1}{x} = -\log_5 x$ •5 reflect in $x-$axis 
3	•1 $b = 2$ •2 $3 = a\log_2 2$ stated or implied or $(4-b)^a = 8$ •3 $a = 3$

4	$\bullet^1$ $x_A = -4 \cdot 5$ $\bullet^2$ $5\log_{10}(2x+10) = 8$ $\bullet^3$ $2x+10 = 10^{\frac{8}{5}}$ $\bullet^4$ $x = 14 \cdot 9$
5	(*a*) $\bullet^1$ graph of $y = 2 - x$ with two annotated points eg (2,0) and (0,2) $\bullet^2$ graph of $y = \log_{10} x$ with one annotated point eg (1,0) $\bullet^3$ any consistent approximation (*b*) $\bullet^4$ between 1.7 and 1.8 $\bullet^5$ between 1.75 and 1.80 $\bullet^6$ 1.76

ANSWERS - **Pre 2000 - Log Equations**

1	$\bullet^1$ $6 \cdot 5 = 10\log_{10}\left(\frac{P}{30}\right)$ $\bullet^2$ $P = 30 \times 10^{0.65}$ $\bullet^3$ 134 phons
2	$\bullet^1$ $x = \log_5 12$ $\bullet^2$ $5^x = 12$ $\bullet^3$ $\log 5^x = \log 12$ $\bullet^4$ $\frac{\log_{10} 12}{\log_{10} 5}$ *or* $\frac{\log_e 12}{\log_e 5}$ *or* $\frac{\log 12}{\log 5} = 1.54$
3	$\bullet^1$ $k = \log_e p$ **and** $k = \frac{1}{2}\log_e q$ $\bullet^2$ $\log p = \frac{1}{2}\log q$ **or** $p = e^k$ **and** $q = e^{2k}$ $\bullet^3$ $q = p^2$ **or** $p = q^{\frac{1}{2}}$ $\bullet^4$ $q = 25$

ANSWERS - **Pre 2000 - Exponential Equations**

1	$\bullet^1$ use logs	*OR*	$\bullet^1$ use logs	*OR*	$\bullet^1$ use exponentials
	$\bullet^2$ $\ln 3^x = \ln 42$		$\bullet^2$ $x = \log_3 42$		$\bullet^2$ $\left(e^{1 \cdot 0986}\right)^x = 42$
	$\bullet^3$ $x \ln 3 = \ln 42$		$\bullet^3$ $x = \frac{\ln 42}{\ln 3}$		$\bullet^3$ $1 \cdot 0986x = \ln 42$
	$\bullet^4$ $3 \cdot 402$		$\bullet^4$ $3 \cdot 402$		$\bullet^4$ $3 \cdot 402$
2	$\bullet^1$ 40 $\bullet^2$ $40e^{1 \cdot 5t} = 80$ $\bullet^3$ $1 \cdot 5t = \ln 2$ $\bullet^4$ $t = 0.46$ $\bullet^5$ 28 minutes				

3

$\bullet^1$ $75 = 100e^{-k\times 15}$

$\bullet^2$ $\ln 0\cdot 75 = -15k$

$\bullet^3$ $k = 0.0192$

$\bullet^4$ $T_{15} = 75e^{-0.0192\times 15}$ *or* $T_{30} = 100e^{-0.0192\times 30}$

$\bullet^5$ fall = 18.75

4

$\bullet^1$ $9 = 10e^{-3k}$

$\bullet^2$ $-3k = \log_e 0\cdot 9$

$\bullet^3$ $0\cdot 04$

$\bullet^4$ $e^{-kt} = 0\cdot 5$

$\bullet^5$ a correct value for t

5

(a)

$\bullet^1$ $m = 500e^{-0.02\times 10}$

$\bullet^2$ 409.37 grams

(b)

$\bullet^3$ $250 = 500e^{-0.02t}$

$\bullet^4$ $\ln 250 = \ln 500 - 0.02t \times 1$ or equiv.

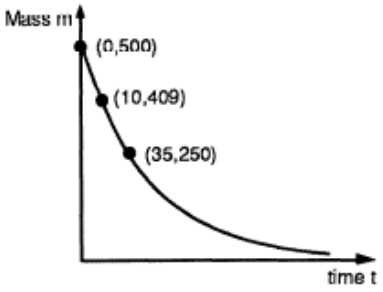
$\bullet^5$ 34.7 years

(c)

$\bullet^6$ any **two** of the 3 points

$\bullet^7$ the remaining point

$\bullet^8$ a decreasing curve



6

$\bullet^1$ $(0,5) \Rightarrow a = 5$

$\bullet^2$ $20 = 5e^{3k}$

$\bullet^3$ *e.g.* $\ln 20 = \ln 5 + 3k \ln e$

$\bullet^4$ $k = 0.462$ (Accept $\frac{1}{3}\ln 4$)

$\bullet^5$ $y = 5e^{k(x-3)}$

7

(a)

$\bullet^1$ $10 = 50e^{-24k}$

$\bullet^2$ $0.2 = e^{-24k}$

$\bullet^3$ $-24k = \ln 0.2$

$\bullet^4$ $-24k = -1.609$

$\bullet^5$ $k = 0.067$

(b)

$\bullet^6$ knowing to find P_4

$\bullet^7$ $P_4 = 50e^{-0.067\times 4}$

$\bullet^8$ 38

$\bullet^9$ $38 > 30$ so can be driven further

8	(a)	•1	$\frac{1}{2}y_0 = y_0e^{5700k}$
		•2	$\ln\frac{1}{2} = 5700k$
		•3	$k = -0.000122$
	(b)	•4	$y = y_0e^{-0.000122\times1000}$
		•5	$\frac{y}{y_0} = \ldots$
		•6	88.5%
9	(a)	•1	$90 = 120e^{-4k}$
		•2	$e^{-4k} = 0.75$ **or** $\ln 90 = \ln 120 + \ln e^{-4k}$
		•3	$\ln 0.75 = -4k$
		•4	$k = 0.0719$
	(b)	•5	$I_{10} = I_0e^{-10\times0.0719}$ *stated or implied by* •6
		•6	$\frac{I_{10}}{I_0} = 0.487$
		•7	51.3% reduction

ANSWERS - **Pre 2000 - Graphs with Log Axes**

1	•1	*use* $y = mx + c$	•4 $\log_{10} y = \log_{10} x^2 + 1$
	•2	$\log_{10} y = 2\log_{10} x + 1$	•5 $\log_{10} y = \log_{10} 10x^2$
	•3	$\log_{10} y = 2\log_{10} x + \log_{10} 10$	•6 $y = 10x^2$
2	(a)	•1	$\log_e y = \log_e ae^{bx}$
		•2	$\log_e y = \log_e a + \log_e e^{bx}$
		•3	$\log_e y = \log_e a + bx$
	(b)	•4	evidence for strategy being carried out will be appearance of two equations at •5 stage
		•5	*e.g.* $3.1b + \log a = 9.99$, $5.2b + \log a = 16.29$
		•6	strategy: know to subtract
		•7	$b = 3$
		•8	$a = e^{0.69}$
		•9	$a = 2$

3	**(a)** $\bullet^1$ *e.g.* $m = 3$ $\bullet^2$ *e.g.* $8.70 = 3 \times 2.65 + c$ *or equiv.* $\bullet^3$ *e.g.* $Y = 3X + 0.75$ **(b)** $\bullet^4$ $\ln y = 3 \ln x + 0 \cdot 7$ $\bullet^5$ $\ln y = \ln 2.01x^3$ $\bullet^6$ $b = 3$ $\bullet^7$ $a = 2.01$
4	**(a)** $\bullet^1$ $m = -\frac{4}{5}$ stated or implied $\bullet^2$ $y = mx + 4$ stated or implied $\bullet^3$ $\log_e I = -\frac{4}{5} \log_e t + 4$ **(b)** $\bullet^4$ $\log_e t^{-\frac{4}{5}}$ $\bullet^5$ $\log_e 54.6$ $\bullet^6$ $\log_e 54.6t^{-\frac{4}{5}}$ $\bullet^7$ $I = 54.6t^{-0.8}$